HOWARDITES AND MESOSIDERITES: CONTRASTING POLYMICT BRECCIAS FROM TWO SIMILAR DIFFERENTIATED ASTEROIDS.

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Introduction: Howardites are polymict breccias composed of fragments of mafic and ultramafic igneous lithologies from the crust of a differentiated asteroid, quite likely 4 Vesta (*e.g.*, [*1, 2*]). Mesosiderites are polymict breccias composed of sub-equal amounts of metal plus troilite, and silicates that are similar to howardites [*1*]. Howardites and mesosiderite silicates are identical in $\Delta^{17}O$ and $\varepsilon^{54}Cr$ [*3, 4*], allowing for formation on a single asteroid; this scenario has recently been championed [*5*]. Nevertheless, differences in formation age based on Mn-Cr chronometry [*6*], and in petrologic and compositional details [*7, 8*] bespeak sourcing on distinct asteroids. I will present petrologic and compositional evidence for howardites and mesosiderites that speak to the question of the number of parent asteroids required.

Petrologic/Compositional Distinctions: Excluding impact-melt materials and chondritic clasts, howardites are composed of lithic and mineral clasts that mostly can be equated with eucrites and diogenites. Some clasts contain phases outside the compositional ranges known from eucrites and diogenites, but nevertheless that can be understood as being magmatic products of the asteroid (*e.g.*, [*9*]). Mesosiderites contain some basaltic clasts that are indistinguishable from eucrites [*7*]. However, the majority of their mafic igneous clasts have anomalous properties including: variable Fe/Mn that is correlated with Fe/Mg; abundant magmatic augite, tridymite and merrillite; xenocrystic plagioclase in basaltic clasts; non-cumulate rocks with almost cumulate-like rare-earth-element patterns; cumulate gabbros with very low incompatible element contents and extremely high Eu/Sm (see [*7, 8*]). The majority of mafic clasts in mesosiderites have some of these anomalous properties, which are interpreted as arising from re-melting primary crustal rocks after metal-silicate mixing [*7, 8, 10*]. Similar materials are absent in howardites. Possible mesosiderite clasts have rarely been reported from howardites [*11*], but these might be exogenous in origin.

Summary: Silicates in mesosiderites commonly show anomalous characteristics compared to howardites. These characteristics indicate that many of the mesosiderite lithologies were formed during and/or after metal silicate mixing. Petrologic evidence indicates that impact gardening occurred on the mesosiderite asteroid after metal-silicate mixing. Thus the anomalous materials ought to be widely distributed on that asteroid. The compositions of howardites suggest a well-mixed regolith on Vesta [*12*]. The lack of distinctive mesosiderite-like materials in howardites favors separate parents for the two meteorite groups.

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